Golden Spread Electric Cooperative, Inc.
A Touchstone Energy® Cooperative

December 4, 2013

Mr. Thomas H. Diggs
Associate Director for Air
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Re: Additional Information Requested
Golden Spread Electric Cooperative, Inc. (GSEC)
Greenhouse Gas (GHG) Prevention of Significant Deterioration (PSD) Permit
Antelope Station, Abernathy, Hale County, TX

Dear Mr. Diggs:

Thank you for providing the November 18 Application Completeness Determination and request for additional information. This letter provides our response to the determination.

The 9 areas for which additional information was requested in the November 18 Application Completeness Determination are reprinted below in *italics*. Our responses follow each numbered area in regular typeface.

1. *Please provide your engineering calculations for the proposed BACT output based limits contained in Table 7 of the permit application and your rationale used to derive the limit. Include any supplemental technical data to support the basis and rationale for the values calculated (i.e. heat rate, fuel composition, operating hours, etc.).*

   GSEC Response: The calculations and bases for the GHG *emission rates* in Table 7 of the July 29, 2013 Permit Application Update were provided in Tables 2-4 of the February 1, 2013 Permit Application for the gas turbine, natural gas piping fugitive leaks, and SF_6 fugitive leaks, and in Tables 5-6 of the July 29, 2013 Permit Application update for the emergency generator and fuel gas heater. The calculated BACT output based limits of CO_2-e per MWh of gross power production from the turbine are supported in the attached table entitled *Bases for BACT Output Levels*. The information in *Bases for BACT Output Levels* is derived from performance values specified by the turbine vendor (GE) for the use of natural gas fuel. Example calculations for the BACT output values are also provided in *Bases for BACT Output Levels.* Note that in this response, we are revising the calculated output values for maximum (100%) load from 1217 to 1228 lbs CO_2-e/MWh (gross), and from 1514 to 1527 lbs CO_2-e/MWh (gross) for any load in the normal operating range of 50-100% load. The revised output based limits are based on a revision to the heat load degradation rate used in the calculation. The value used for the turbine emission limit at any load in the normal operating range is the maximum value determined over the range of ambient air temperatures and normal operating loads. The maximum limit on power generation was calculated conservatively as the hours of operation, including startup and shutdown periods, and the maximum power generating capacity of the proposed turbine.[1]

2. *The application indicates a proposal for 635 startup and 635 shutdown events for each turbine. Please provide supplemental data to support the rationale for this number of proposed startups and shutdowns. The discussion should include a detailed explanation of the power plant's anticipated operating mode that justifies the proposed startup and shutdown events used to calculate the emission limits.*

   GSEC Response: As noted in the Permit Application, the proposed turbine is intended to provide both peaking and intermediate power needs in a highly cyclical operation. GSEC has historically provided electrical power only to the Southwest Power Pool (SPP). The proposed turbine facility is designed to supply both the SPP and the Electric Reliability Council of Texas (ERCOT), and this need to supply two power pool service areas is the primary factor affecting the number of anticipated startup and shutdown events. In addition, due to the current and expected increase in wind power generation in both the SPP and ERCOT service areas, additional generation resources are required to maintain grid stability and meet load when weather conditions are not conducive to wind energy production. Simple cycle units such as the proposed turbine facility are able to complement and support wind energy production because of their fast start capabilities. This fast start capability allows simple cycle turbines to support grid reliability and stability by quickly meeting load demands when wind speeds suddenly slow causing wind generated power to drop off.

   The proposed number of startup and corresponding shutdown events reflects an average of just under two startup and shutdown events per day over the course of a year. The proposed value is 25% above the levels typically authorized in GSEC's other turbine facilities which were designed to support only the needs of the SPP.

3. *Please provide supplemental benchmark data that compares the energy efficiency of the selected GE 7F 5-Series gas-fired combustion turbine to similar or existing sources. Were other units considered for the proposed project from an energy efficiency/emissions perspective? Please supplement the current BACT analysis to include the energy/emissions evaluation performed to determine why this turbine was proposed for this project. Please include comparative design data that includes heat load and efficiency data of the other units that were considered in addition to the one that was selected. (This information can be graphically represented). For example, the permit application notes the existing plant is made up of 18 quick start engines. Was a technical assessment performed to use additional quick start engines for this project and/or different design configurations of turbines and engines to provide the most efficient operation for the proposed project?*

   GSEC Response: Golden Spread selected a GE Series 5 turbine after an extensive evaluation of operating needs and available equipment. The evaluation considered simple cycle units, combined cycle plants and reciprocating engines in an attempt to match plant capabilities with member COOP needs, and the needs of the power pools. The combination of output, fast-start capability,

[1] Calculation of maximum power production = (4000 normal hours + 317.5 startup hours + 254 shutdown hours) X (202 MW) = 923,443 MWh (gross)/year.

environmental considerations, and efficiency of the GE turbine were found to match Golden Spread's needs better than the other options.

Several factors affected Golden Spread's selection of the GE Series 5 machines over other manufacturers such as Siemens or the addition of more Wärtsilä reciprocating engines. The Series 5 has a better heat rate than a comparable Siemens unit and lower installed and annualized costs than either a Siemens unit or additional Wärtsilä engines. Heat rates and efficiency data for the Series 5 turbine, a comparable Siemens SGT5-2000E turbine, and the Wärtsilä engines are shown below.

Heat Rate and Efficiency Data for Three Power Production Options*

	Siemens SGT5-2000E	GE 7FA Series 5	Wärtsilä 20V34SG
Heat Rate, BTU (LHV)/kWh (gross)	9659	8905	7744
Energy Efficiency	35.5	38.3	44.1

*At full load and at ambient air temperatures of 50-61°F

Although the nominal heat rate of the Wärtsilä engines currently installed at Antelope Station is 13% lower than the heat rate of the proposed GE Series 5 unit, and new engines thus would have lower GHG emissions, the Wärtsilä engines would generate more than 100 tons/year additional $PM_{10}/PM_{2.5}$ emissions, more than 100 tons/year additional emissions of hazardous air pollutants, and approximately 200 tons/year additional emissions of VOC emissions, compared to the GE 7FA Series 5 turbine. Coupled with the increased operational and maintenance requirements and complexities of multiple engines compared to a single turbine, the ability to very quickly add approximately 200 MW of capacity in a highly efficient single production unit, and the higher capital and annualized costs of the engines, GSEC selected the GE turbine as the best overall production option.

Compared to other turbine manufacturers, the GE equipment provides GSEC the ability to coordinate common maintenance practices and share common parts with the other five GE combustion turbines in our fleet. This provides significant economic flexibility and reliability to our generating plants.

The choice between simple cycle units and combined cycle units was based largely on operating flexibility and available water. The location of our facility is adjacent to a large concentration of wind energy. A simple cycle unit has the flexibility to start, stop, ramp up and ramp down very quickly in order to "follow" wind loads on our system. Combined cycle technology does not currently offer equivalent 'fast start' capability. This is extremely important to the transmission balancing authority in our area and adds considerable value to the generation unit. In addition to the superior fast start capabilities, simple cycle plants consume less water than combined cycle plants. The water level in the local aquifers has declined over the last several years and is becoming scarce. Consequently, technology evaluations must consider the future availability and value of water among the various selection criteria.

4. *Please provide your preferred ongoing compliance monitoring methods for all GHG emission units. Please let us know whether you are proposing to install CEMs due to other non-GHG monitoring requirements and whether that would include continuous CO2 monitoring.*

GSEC Response: GSEC has proposed to install CEMs to continuously monitor emissions of nitrogen oxides, and carbon monoxide from the gas turbine. In addition, a CEMS will continuously monitor oxygen levels, and the plant information system will continuously monitor and record both natural gas fuel usage and electrical power production from the turbine. As noted in Table 7 of the Permit Application Update, hourly and annual CO_2-e emissions from the turbine, and annual emissions from the emergency generator and fuel gas heater will be determined using 40 CFR 98.43 based on recorded fuel usages. Emissions of SF_6 will be determined from inventory records on a calendar year basis. Annual emissions of natural gas piping fugitive leaks will be determined from the source counts and emission factors presented in the Permit Application. Any observations of piping system leaks will also be recorded.

5. *Are the proposed BACT limits applicable at all times, including startup and shutdown? Please supplement the application by indicating whether your proposed BACT includes startup and shutdown emissions, or provide supplemental information that details why a different BACT limit is needed during startup and shutdown along with a proposed BACT analysis for such startup/shutdown emissions.*

GSEC Response: Emissions from startup and shutdown operations are included in the emission rates listed in Table 7, but are not included in the proposed BACT output based limits. Output based limits are very difficult if not impossible to accurately specify for startup and shutdown operations, because emissions occur during parts of these operations without any power production, and because emissions and loads vary substantially during the remaining portions of the startup or shutdown. Emissions in any hour of operation that include startups or shutdowns will be at most no more than 1.5% higher than emissions in any hour of normal maximum load operation, regardless of the establishment of an output based factor. Overall these emissions are minimized by the use of an automated combustion control program. The actual emissions of GHG will be determinable in each hour of operation, including startups and shutdowns, using the plant information system's tracking of fuel usage.

6. *BACT is a case-by-case determination. Please provide site-specific facility data to evaluate and eliminate carbon capture sequestration (CCS) from consideration as an add-on control for BACT. The suggested data that would be helpful includes detailed information on the quantity and concentration of CO2 that is in the flue gas stream and the necessary equipment for capture. transportation, and storage. In addition. the capital cost of construction, annual operation and maintenance costs, for a CCS system would be helpful as well. Please discuss in detail any site specific safety or environmental impacts associated with such a CCS system. Also, please provide any additional technical and economic details for this project and its potential for installing a CCS system for recovering CO2 for enhanced oil recovery (EOR) and non-EOR geologic sequestration.*

GSEC Response: GSEC offers that nearly all of this information was already provided in the BACT analysis included Sections 6.1.2 and 6.1.4 of the Permit Application. The information used to estimate the cost of CCS for use at Antelope Station included only recent cost studies, including Carnegie Mellon University's Integrated Environmental Control Model. That model uses as its basis GE 7F class turbines like that proposed for Antelope Station. The level of information detail provided in this analysis is comparable to that accepted in other BACT determinations, and is our best estimate of the costs of CCS at Antelope Station. As noted in Section 6.1.4, the costs we have developed are thought to be conservatively low, yet they result in cost impacts which are very severe, and not economically reasonable. These costs included a capital cost of $196 million for a CCS system, annualized operation and maintenance costs of $29-50 million per year, and a cost effectiveness of $61-104 per ton of CO_2 removed, with an increased cost of electricity production of $0.03-0.05/kWh. Note that the expected capital costs of the CCS system are nearly twice that of the capital cost of the turbine facility itself (currently estimated as approximately $110 million.) We suggest that this information overwhelmingly demonstrates that CCS is not economically viable on the state-of-the-art simple cycle gas turbine facility proposed at Antelope Station. Also, as noted in the Permit Application, because of the lack of demonstration of CCS on gas turbine power plants, and other power plant applications, lack of commercial deployment, lack of a transport pipeline, and uncertainties on the possible use of the CO_2 for EOR or for storage in geologic storage sites, CCS is not considered to be a technically viable option. We suggest that the use of CCS in a turbine facility with frequent startups and shutdowns is also not technically viable.

7. *Please provide supplemental data that discusses the rationale for the addition of the natural gas heater to the proposed design.*

GSEC Response: The primary purpose of the fuel gas heater is turbine protection. In order to protect the gas turbine from damage due to hydrocarbon and moisture condensation, GE requires a minimum superheat in the fuel gas which varies based on gas pressure and gas constituents. The minimum superheat is generally 50°F above the hydrocarbon and moisture dew point temperatures.

8. *Table 7 states that equipment will be operated and maintained according to manufacturer recommendations. Please describe in more detail specific operation and maintenance procedures your facility will perform, how often, and how record keeping will be done.*

GSEC Response: Operation practices of the GE F class turbine are highly automated. Fuel flow to the fuel nozzles is controlled by independent control valves, each controlling flow split and unit load. Fuel flow is regulated by a command signal from the gas turbine control panel. The primary controlling parameter for fuel staging is the calculated combustion reference temperature. Optimal combustor operation is dependent upon proper operation along the predetermined temperature control scheme which varies with load and other operating factors. Parameters monitored during normal operation include: speed, load, barometric reading, temperatures (inlet ambient, compressor discharge, turbine exhaust, turbine wheelspace, lube oil header, lube oil tank, bearing metal, bearing drains, exhaust), pressures (compressor discharge, lube pumps, bearing header, cooling water, fuel, fuel/lube/inlet air filters), vibration, and generator voltages and currents. Operational records are maintained by the plant information system.

Three defined inspection-repair activities are specified by GE. Each are triggered by the number of hours operated or the number of start-ups, whichever occurs first. These defined inspections are as follows, in order of increasing comprehensiveness:

- Combustion Inspection-Repair = every 12,000 hours or 450 starts
- Hot Gas Path Inspection-Repair = every 24,000 hours or 1200 starts
- Major Inspection-Repair = every 48,000 hours or 2400 starts.

In addition to these inspection-repair activities, standing inspections and servicing are conducted when the turbine is not operating. These standing inspections and servicing include routine battery servicing, changing filters, checking oil and water levels, and checking relays and calibrations. Running inspections are also conducted primarily to compare operating parameters to baseline operating data. Boroscope inspections of the gas path will also be conducted at the time of combustion inspections or annually, whichever occurs first.

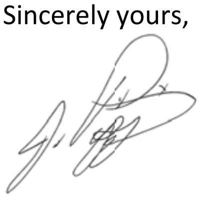
9. *Golden Spread proposes to use periodic AVO monitoring. Please provide supplemental data that discusses the details of what this program will involve. What is the proposed compliance strategy including recordkeeping, schedule. and the protocol for equipment repairs? Is there a TCEQ LDAR method that would be preferred to use? Please provide supplemental data that includes the basis for utilizing this preferred method versus other potential methods.*

GSEC Response: The baseline emission factors used to calculate GHG emissions from natural gas piping fugitive leaks presume no use of an instrument based monitoring protocol. Emissions for the baseline emission factor are based on the sporadic observation (through personnel audio, visual, or olfactory sensing) of leaks. The baseline specifies no directed monitoring of leaks, but includes their observation and repair as may occur during other plant activities. The BACT analysis in Section 6.2 of the Permit Application includes specific consideration of TCEQ LDAR methods, including both instrument detection of leaks and remote sensing of leaks, but found that neither of these methods could be implemented cost effectively, with costs of \$150-290/ton CO_2-e controlled.

GSEC proposes to implement periodic AVO monitoring through monthly observations of the plant natural gas piping system, as well as other observations which occur sporadically during normal plant operations. Logs will be maintained of the observations, any discovered leaks, and the maintenance actions taken to repair the leaks.

If you or your staff have additional questions or require additional information, please contact me. Our air quality consultant Pat Murin can also be contacted any time to respond to questions and issues. Both myself and other GSEC technical and management staff are also available to respond to questions and issues that may develop during the permit application review.

Sincerely yours,



Jeff Pippin
Senior Asset Manager, Production

Enclosure
cc: Mr. Mike Wilson, P.E., Director, Air Permits Division, TCEQ

Estimated Performance Data (GE)

Load Condition	BASE	BASE	BASE	BASE	BASE	75% LOAD	75% LOAD	75% LOAD	75% LOAD	75% LOAD	50% LOAD	54% LOAD	50% LOAD	50% LOAD	50% LOAD
Ambient Temperature, °F	98	-10	110	50	20	98	-10	110	50	20	98	-10	110	50	20
Turbine Output, MW (gross)	190.115	199.546	185.459	195.287	202.067	151.551	151.551	151.551	151.551	151.551	101.034	109.116	101.034	101.034	101.034
Heat Rate (LHV), BTU/kWh	8905	8828	8950	8783	8732	9268	9544	9311	9206	9281	10698	10966	10680	10842	11118
Exhaust Flow, 1000 lbs/hr	3688	3877	3620	3710	3818	3090	3206	3150	3028	3108	2426	2662	2437	2417	2491
Exhaust MW, lbs/lb-mol	28.28	28.52	28.22	28.49	28.51	28.39	28.52	28.34	28.49	28.52	28.4	28.53	28.35	28.5	28.52
UHC, lbs/hr	15	15	14	15	15	12	13	12	12	12	10	10	10	9	10
CO_2, % vol	3.89	3.89	3.88	3.95	3.95	3.87	3.86	3.81	3.94	3.87	3.8	3.85	3.77	3.87	3.86

Calculated Performance Parameters

Load Condition	BASE	BASE	BASE	BASE	BASE	75% LOAD	75% LOAD	75% LOAD	75% LOAD	75% LOAD	50% LOAD	54% LOAD	50% LOAD	50% LOAD	50% LOAD
Ambient Temperature, °F	98	-10	110	50	20	98	-10	110	50	20	98	-10	110	50	20
CH_4, lbs/hr	12	12	11.2	12	**12**	9.6	10.4	9.6	9.6	9.6	8	8	8	7.2	8
N_2O, lbs/hr	5.59	5.81	5.48	5.66	**5.82**	4.64	4.77	4.66	4.6	4.64	3.57	3.95	3.56	3.61	3.71
CO_2, lbs/hr	223,210	232,674	218,996	226,324	**232,749**	185,335	190,921	186,332	184,252	185,565	142,826	158,059	142,592	144,409	148,342
CO_2-e, lbs/hr	225,195	234,727	220,930	228,331	**234,805**	186,975	192,618	187,978	185,880	187,205	144,101	159,452	143,864	145,679	149,660
CO_2, lbs/MWh	1209	1201	**1216**	1194	1186	1260	1298	1266	1252	1261	1456	1492	1454	1472	**1512**
CO_2-e, lbs/MWh	1221	1213	**1228**	1205	1198	1272	1310	1279	1264	1273	1470	1507	1468	1486	**1527**

Red values denote maximum values over range of normal operation.

Factors Used for Calculations

CH_4/UHC, % as a fraction	0.8	*Based on GE data for VOC and total HC emissions.*
HHV/LHV	1.1	*Typical ratio.*
N_2O emission factor, lbs/MM BTU (HHV)	0.003	*From EPA's AP-42, Table 3.1-2a*
GHG warming equivalency factors, lb CO_2-e/lb:		*From GHG Warming Potential Equivalency Factors (40 CFR Part 98 Subpart A, Table A-1)*
- CO_2	1	
- CH_4	21	
- N_2O	310	
Heat Rate degradation factor, %	3	*Based on degradation in heat rate between major overhauls.*

Example Calculations (Base Load, 98°F Ambient)

CH4: (15 lbs UHC/hr) X (0.8 lbs CH4/lb UHC) = 12 lbs CH4/hr

N2O: (190115 kW) X (8905 BTU-LHV/kWh) X (MM BTU/1,000,000 BTU) X (1.1 BTU-HHV/BTU-LHV) X (0.003 lbs N2O/MM BTU-HHV) = 5.59 lbs N2O/hr

CO2: (3688000 lbs exhaust/hr) X (lb-mol exhaust/28.28 lbs exhaust) X (3.89 lb-mol CO2/100 lb-mol exhaust) X (44 lbs CO2/lb-mol CO2) = 223210 lbs CO2/hr

CO2-e: (223,210 lb CO2/hr) X (1lb CO2-e/lb CO2) + (12 lbs CH4/hr) X (21 lb CO2-e/lb CH4) + (5.59 lbs N2O/hr) X (310 lb CO2-e/lb N2O) = 225195 lbs CO2-e/hr

CO2-e, lbs/MWh: (225195 lbs CO2-e/hr) / [190.115 MW (gross) X (100% - 3 % HR degradation)/100%] = 1221 lbs CO2-e/MWh

The seal appearing on this document was authorized by Patrick J. Murin, P.E. 67271 on 12/3/2013
P.E. Expiration Date: 12/31/2013

Murin Environmental Inc.
TBPE Registration No. F-7702
Firm Registration Expiration Date: 3/31/2014